

学校编码: 10384

分类号\_\_\_\_\_密级\_\_\_\_\_

学号: 31520101153187

UDC\_\_\_\_\_

厦门大学

## 硕士学位论文

# 面向领域的多阶段融合图像分类方法研究

Research on the Domain-oriented Multistage Fusion

Methods of Image Classification

石蒙蒙

指导教师姓名: 李绍滋 教授

专业名称: 模式识别与智能系统

论文提交日期: 2013 年 5 月

论文答辩时间: 2013 年 6 月

学位授予日期: 2013 年 月

答辩委员会主席: \_\_\_\_\_

评阅人: \_\_\_\_\_

2013 年 5 月

厦门大学博硕士论文摘要库

## 厦门大学学位论文原创性声明

本人呈交的学位论文是本人在导师指导下,独立完成的研究成果。本人在论文写作中参考其他个人或集体已经发表的研究成果,均在文中以适当方式明确标明,并符合法律规范和《厦门大学研究生学术活动规范(试行)》。

另外,该学位论文为( )课题(组)的研究成果,获得( )课题(组)经费或实验室的资助,在( )实验室完成。  
(请在以上括号内填写课题或课题组负责人或实验室名称,未有此项声明内容的,可以不作特别声明。)

声明人(签名):

年 月 日

厦门大学博硕士论文摘要库

## 厦门大学学位论文著作权使用声明

本人同意厦门大学根据《中华人民共和国学位条例暂行实施办法》等规定保留和使用此学位论文，并向主管部门或其指定机构送交学位论文(包括纸质版和电子版)，允许学位论文进入厦门大学图书馆及其数据库被查阅、借阅。本人同意厦门大学将学位论文加入全国博士、硕士学位论文共建单位数据库进行检索，将学位论文的标题和摘要汇编出版，采用影印、缩印或者其它方式合理复制学位论文。

本学位论文属于：

(        )1.经厦门大学保密委员会审查核定的保密学位论文，  
于     年    月    日解密，解密后适用上述授权。

(    ☒    )2.不保密，适用上述授权。

(请在以上相应括号内打“√”或填上相应内容。保密学位论文应是已经厦门大学保密委员会审定过的学位论文，未经厦门大学保密委员会审定的学位论文均为公开学位论文。此声明栏不填写的，默认为公开学位论文，均适用上述授权。)

声明人(签名)：

年    月    日

厦门大学博硕士论文摘要库

## 摘要

图像检索技术涉及多项应用领域，除通用的图像检索系统之外，越来越多特定领域的图像检索系统正在涌现，如 Yottalook 医学图像检索系统等。图像分类是图像检索系统中最为基础性的工作之一，因此面向领域的图像分类技术具有广阔的应用前景，特别是文档图像和医学图像领域。因此，本文的研究工作具有很好的应用前景和较好的理论意义。

由于图像的复杂性、类别之间的干扰、类别的多样性等因素，特定领域的图像分类问题仍然是一个充满挑战的问题。本文针对文档图像和医学图像分类存在的问题展开研究，主要工作以及创新点如下：

1、归纳总结现有方法。查阅大量文献，对当前图像分类方法进行全面的归纳和总结，介绍了常用方法的基本思想和原理，分析比较了各方法的优缺点；并且详细分析文档图像和医学图像领域的图像分类方法。

2、针对目前文档分类方法依赖于图像分割以及 OCR 等预处理的问题，本文提出了一种简单但有效的图像分类方法。采用结构化局部边缘模式（SLEP: Structured Local Edge Pattern）作为图像特征，利用支持向量机 SVM 作为分类器实现文档图像分类。为了验证本文方法的有效性，创建了文档图像数据库。实验结果表明，基于 SLEP 特征的方法，避免了复杂的预处理，实验结果在准确率、召回率等方面都明显优于所对比方法，并且即使在文档图像低分辨率的情况下，所分类结果仍然有不错表现。

3、提出一种多阶段融合的方法对医学图像分类。采用 ImageCLEF2012 医学图像分类比赛作为实验数据集，构建多阶段特征融合的图像分类器。为每类特征构建相应的图像分类器，然后对分类结果进行融合，最终实现图像分类。实验结果表明，所提出的多阶段融合的方法可以更全面地描述医学图像的特性，进一步提升了图像分类准确率，同时本文的分类结果也排于 ImageCLEF2012 医学图像分类比赛结果的前列。

总之，本文面向文档图像领域和医学图像领域，由浅入深，从图像特征提取和分类过程两个核心问题入手，首先建立了一个文档图像数据库，然后将 SLEP

特征应用到文档图像分类之中，最后针对医学图像的复杂性，在之前研究工作的基础上，提出了一种多阶段融合的方法。文档图像分类方面，**SLEP** 特征实现了非常高的准确率；医学图像分类方面，多阶段融合特征则更好地解决医学图像分类问题，相较于其他方法有明显的改进。

**关键词：**图像分类；面向领域；特征提取；结构化局部边缘模式



## Abstract

Image retrieval technique is related to many application fields. Besides general image retrieval system, more and more domain specific image retrieval systems spring up such as Yottalook Medical Image Retrieval System. Field-oriented image classification technique has a broad application prospect especially for the document images and medical images, because image classification is one of the most basic works in image retrieval system. Therefore, this study has a good prospect of application and better theoretical significance.

For the complexity of images, the interference among categories, the diversity of categories and some other factors, field-oriented image classification is still a problem full of challenges. This paper study on the existing problems in classification of document images and medical images, main works and innovations are as follows:

1. We generalize and summarize current methods. Through the research on abundant references, we conduct the current image classification methods as comprehensive induction and summary. This paper have introduced basic ideas and principles of common methods and analyzed merits demerits of each method comparatively. In addition, analysis of document images and medical images' classification methods are detailed.

2. Propose a simple but effective method for image classification , in allusion to the present document classification methods' problems caused by dependence on image segmentation and some pretreatment problems like OCR. We take structured local edge pattern (SLEP) as image' features and realize the document images' classification with support vector machine (SVM) as a classifier. To validate the superiority of the method, we create a document image database in advance. The experiments show that, our method based on SLEP features bypasses the complex pretreatment, and it outperforms the chosen methods for contrasts both in the accuracy and recall rate. Moreover, out classification method has a good performance

even for the document images with low resolution.

3. Propose a method based on multi-stage features fusion for medical image classification. In this paper, we take ImageCLF2012 medical images' classification match as the experimental data set to construct image classifier on multi-feature fusion. The corresponding image classifier to each type of features are constructed and then the final image classification is implemented by the fusion of classification results. The experiments prove that, our feature fusion method can describe the properties of medical images more comprehensively. And at the same time, our result ranks top among the results of ImageCLEF2012 medical images classification match.

In a word, this paper caters to document and medical images according to the image feature extraction and classification process from the shallower to the deeper. We firstly create a database of document images, and then apply SLEP features in the classification for document images. At last, aiming at the complexity of medical images, we proposed a multi-stage feature fusion method based on the past related research work. SLEP features lead to a high accuracy and multi-stage feature fusion method provides a better solution for the problem about medical images' classification with obvious improvement compared with the other methods.

**Key Words:** Image Classification; Field-oriented; Feature Extraction; Structured Local Edge Pattern

# 目录

摘要 .....	I
Abstract.....	III
<b>第一章 绪论 .....</b>	<b>1</b>
1.1 选题的背景与意义 .....	1
1.2 研究现状及存在的问题 .....	2
1.2.1 图像分类问题描述 .....	3
1.2.2 研究现状 .....	3
1.2.3 面向领域的图像分类 .....	8
1.3 本文主要研究工作 .....	12
1.4 本文组织结构 .....	13
1.5 本章小结 .....	14
<b>第二章 图像分类的常用特征模型及分类算法 .....</b>	<b>15</b>
2.1 图像特征概述 .....	15
2.1.1 梯度直方图 .....	15
2.1.2 尺度不变特征转换 .....	17
2.1.3 局部二值模式 .....	22
2.1.4 局部边缘模式 .....	24
2.1.5 空间金字塔模型 .....	25
2.1.6 图像熵 .....	28
2.1.7 HSV 颜色空间 .....	29
2.2 图像分类算法概述 .....	29
2.2.1 K 均值算法 .....	29
2.2.2 决策树分类 .....	30
2.2.3 神经网络分类 .....	30
2.2.4 SVM 分类 .....	31
2.2.5 词袋模型分类 .....	36

2.3 本章小结 .....	36
<b>第三章 基于结构化边缘模式的文档图像分类算法.....</b>	<b>38</b>
3.1 文档图像分类问题研究现状 .....	38
3.2 基于结构化边缘模式的文档图像分类 .....	39
3.3 文档图像分类特征提取 .....	40
3.3.1 SLEP 特征提取 .....	40
3.3.2 HOG 特征提取 .....	41
3.3.3 对比融合特征提取 .....	42
3.4 文档图像分类模型 .....	42
3.4.1 分类框架图 .....	42
3.4.2 实验数据集的构建 .....	43
3.4.3 性能评估 .....	44
3.4.4 交叉验证 .....	44
3.5 实验分析 .....	45
3.5.1 实验总体表现 .....	45
3.5.2 不同分辨率下分类结果分析 .....	46
3.5.3 分类成功与失败的例子 .....	48
3.6 本章小结 .....	49
<b>第四章 基于多阶段融合的医学图像分类算法.....</b>	<b>51</b>
4.1 医学图像分类研究现状 .....	51
4.2 基于多阶段融合的医学图像分类方法 .....	52
4.2.1 多阶段融合方法的实现过程 .....	52
4.2.2 多阶段融合方法融合的图像特征 .....	55
4.2.3 多阶段融合方法分类模型 .....	58
4.2.4 多阶段融合方法分类过程 .....	59
4.3 基于多阶段融合的医学图像分类实验及分析 .....	60
4.3.1 ImageCLEF2012 实验数据集 .....	60
4.3.2 评价方法 .....	63
4.3.3 特征融合阶段分类结果对比 .....	63

4.3.4 分类结果融合阶段实验结果对比 .....	65
4.4 本章小结 .....	66
<b>第五章 总结与展望 .....</b>	<b>67</b>
5.1 回顾与总结 .....	67
5.2 未来研究工作期望 .....	68
<b>参考文献 .....</b>	<b>70</b>
<b>致谢.....</b>	<b>76</b>
<b>附录 攻读硕士学位期间发表的论文 .....</b>	<b>77</b>

厦门大学博士论文摘要库

## Table of Contents

<b>Chapter 1 Introduction .....</b>	<b>1</b>
<b>1.1 Background and Significance .....</b>	<b>1</b>
<b>1.2 Present Research and Problems .....</b>	<b>2</b>
1.2.1 Image Classification Problem Description .....	3
1.2.2 Present Research .....	3
1.2.3 Field-oriented Image Classification .....	8
<b>1.3 Main Research Contents .....</b>	<b>12</b>
<b>1.4 Outline.....</b>	<b>13</b>
<b>1.5 Conclusion .....</b>	<b>14</b>
<b>Chapter 2 Common Characteristics and Sorting Algorithms of Image Classification .....</b>	<b>15</b>
<b>2.1 Overview of Image Features .....</b>	<b>15</b>
2.1.1 Histogram of Oriented Gradient .....	15
2.1.2 Scale-Invariant Feature Transform .....	17
2.1.3 Local Binary Pattern .....	22
2.1.4 Local Edge Pattern .....	24
2.1.5 Space Pyramid Model .....	25
2.1.6 Image Entropy.....	28
2.1.7 HSV Color Space .....	29
<b>2.2 Overview of Sorting Algorithms.....</b>	<b>29</b>
2.2.1 K-means Classifier.....	29
2.2.2 Decision Tree Classification .....	30
2.2.3 Neural Network Classifier .....	30
2.2.4 SVM Classifier.....	31
2.2.5 Bag of Words Model Classifier.....	36
<b>2.3 Conclusion .....</b>	<b>36</b>
<b>Chapter 3 Document Image Classification Based on Structured Local</b>	

<b>Edge Pattern.....</b>	<b>38</b>
<b>3.1 Present Research on Document Image Classification .....</b>	<b>38</b>
<b>3.2 Document Image Classification Based on Structured Local Edge Pattern .....</b>	<b>39</b>
<b>3.3 Feature Extraction from Document Image .....</b>	<b>40</b>
3.3.1 SLEP Feature Extraction.....	40
3.3.2 HOG Feature Extraction .....	41
3.3.3 Compared Fusion Feature Extraction .....	42
<b>3.4 Document Image Classification Model .....</b>	<b>42</b>
3.4.1 Framework .....	42
3.4.2 Data .....	43
3.4.3 Performance Evaluation.....	44
3.4.4 Cross Validation .....	44
<b>3.5 Experimental Analysis.....</b>	<b>45</b>
3.5.1 The Experiment's Overall Performance .....	45
3.5.2 Results Analysis under Different Resolutions .....	46
3.5.3 Success and Failure Examples .....	48
<b>3.6 Conclusion .....</b>	<b>49</b>
<b>Chapter 4 Medical Image Classification based on Multistage Fusion .....</b>	<b>51</b>
<b>4.1 Present Research of Medical Image Classification .....</b>	<b>51</b>
<b>4.2 Medical Image Classification Method based on Multiple Fusion .....</b>	<b>52</b>
4.2.1 Implementation Process of Multistage Fusion Method .....	52
4.2.2 Multistage Fusion Method of image characteristics .....	55
4.2.3 Multistage Fusion Method Classification Model.....	58
4.2.4 Multi-stage Classification Process Fusion Method.....	59
<b>4.3 Medical Image Classification based on Multistage Fusion Experiment and Analysis.....</b>	<b>60</b>
4.3.1 ImageCLEF2012 Experimental Data Set Introduction.....	60



Degree papers are in the "[Xiamen University Electronic Theses and Dissertations Database](#)". Full texts are available in the following ways:

1. If your library is a CALIS member libraries, please log on <http://etd.calis.edu.cn/> and submit requests online, or consult the interlibrary loan department in your library.
2. For users of non-CALIS member libraries, please mail to [etd@xmu.edu.cn](mailto:etd@xmu.edu.cn) for delivery details.

厦门大学博硕士论文摘要库